Background and Summary Report

FINAL

Thornton Creek Habitat Restoration Project
City of Seattle, Matthews Beach Park

Seattle, Washington
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US Army Corps
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Seattle District

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Thornton Creek Habitat Restoration Project
Seattle Parks and Recreation Department
Matthews Beach Park
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EXECUTIVE SUMMARY

Prior to Lake Washington Ship Canal (LWSC) project development, Thornton Creek entered Lake Washington in a shallow gradient several hundred yards upstream of the present creek mouth. The old creek mouth area included extensive wetlands. Lowering of the lake level exposed more land to development and resulted in the loss of wetlands and shoreline habitat. This degradation includes the Matthews Beach Park area, which although a "green space", is relatively poor habitat compared to an undeveloped area. A section of this public park is the basis for the project.

This report summarizes five (5) years of monitoring results for the Thornton Creek Habitat Restoration Project at Matthews Beach. Biological monitoring commenced in 1999 following project implementation in 1998. The purpose of this project is to reestablish natural ecosystem functions at the Thornton Creek mouth by restoring fish and wildlife habitat and wetlands. Results are semi-quantitative and partially rely on best professional judgment of biologists performing the reviews. Monitoring results are used as reference to determine how effectively the project achieved the project goals. Project goals include restoration of native fish and wildlife habitat, enhancement of wetland functions, restoration of native plant communities and control of invasive plant species. Monitoring protocols were performed for Vegetation, fish, invertebrates, and terrestrial wildlife.

Vegetation monitoring was performed to measure the success of plantings, presence and control of invasive species, and presence of volunteer species in the restoration area. Success of the planting effort was also used as the primary performance standard to determine success of the wetland/creation enhancement. Most of the vegetation in the planting zones is establishing well, perhaps in spite of the heavy clay composition of the underlying soil. Cover of trees, shrubs and herbaceous vegetation is robust. Most plants are in reasonably good health, with minimal indication of plant stress or isolated occurrence of mortality. One planting zone, Wildlife Transition Zone C, has experienced a high degree of plant mortality. Surviving vegetation appears stressed due to the hydrologic conditions resulting from poor soil. Invasive species have been significantly reduced in the terrestrial habitats. However, Eurasian water milfoil (*Myriophyllum spicatum*) has infested the fish-rearing pond. Eurasian water milfoil is a Noxious Weed of the State of Washington.

Recommendations for on-going maintenance and adaptive management of vegetation include, maintenance of the view corridors to permit residential lake views and discourage delinquent after hours activities. Proper maintenance by Seattle Parks Department may discourage residents from intentionally killing trees for view and surveillance purposes. Where dense regrowth of red alder is occurring, selective thinning should be performed to facilitate growth of retained specimens. Wildlife Transition Zone C should be replanted with a more suitable assemblage of species for the unique soil and water conditions in that zone. Non-invasive ornamental trees or shrubs could be considered for this zone. The Thornton Creek riparian zone (Shrubby Wetland Zone A) should be replanted. The same species as specified in the Landscape plan should be planted, however containerized material placed about 1 foot back from top of bank may result in greater survival. Manual control of invasive weeds should continue. Eurasian water milfoil

should be hand-removed by divers annually in the early growing season. On-going monitoring should occur to determine the duration of annual maintenance of this Noxious weed.

The Matthews Beach Restoration project included creation of a juvenile fish (salmonid) rearing pond. The purpose of the restoration feature was to create rearing and refuge habitat for juvenile salmonids. The pond was not intended to be stocked, but rather was intended for volitional use by juvenile salmon from adjacent Thornton Creek. However, unknown to the Corps of Engineers, juvenile Coho and Chinook salmon were stocked in the pond during 2001 and 2002. Stocking the pond biased the results of the study during these two monitoring years. The results of the 5-year monitoring period show that cutthroat are the primary species of salmonids that naturally utilize the pond. Only a small number of Chinook were captured in the pond and the majority of these were caught during 2001 and 2002 when they were being planted. In a similar trend, coho populations have declined to zero following termination of pond stocking.

Recommendations for on-going maintenance and adaptive management for Fisheries include annual maintenance of the sedimentation pond. Sediment must be removed annually to reduce sediment layers accumulating in the rearing pond. In coordination with WA Dept. of Fish & Wildlife, Seattle Parks could consider planting coho in the rearing pond if the spawning success in Thornton Creek cannot be improved. Water quality monitoring is recommended to determine if unusually high concentrations of phosphates, nitrates, and total carbonate are contributing to the growth of filamentous algae. In order to provide shading of the rearing pond, riparian vegetation adjacent to the pond should be promoted.

Benthic monitoring was performed annually in a diverted Thornton Creek tributary. Water feeding the created stream reach originated as one of many small springs from the hillsides above Lake Washington, and previously bypassed Thornton Creek and fed directly to Lake Washington at the south end of the project area. The flow was diverted into the fish rearing pond that outlets to Thornton Creek. The purpose of benthic invertebrate monitoring was to assess the presence of invertebrates as biological indicators of overall stream health. Given the limited sampling and seasonal differences in sample collection, only very general interpretations can be obtained from the results. Overall, the benthic community that has developed in this restored stream segment appears to be one found generally in lower gradient streams on finer mineral substrates. It is possible that the significant variations in taxa richness and abundance can be correlated to flow and the individual hydrograph of the individual water years, drought and flood for instance. If the sponsor wishes to learn more about the trophic structure which the fish in the pond rely on, they may want to commission a more detailed study.

A Wildlife Benefit Analysis stated that Thornton Creek and its surrounding habitat at Matthews Beach Park minimally supported wildlife. It further went on to say that the existing buffer strip was too narrow and sparsely vegetated, and was dominated by exotic plant species, essentially making the habitat unattractive to most wildlife species. The proposal put forth in the restoration plan for wildlife was to enhance the surrounding habitat to attract, in some cases, a specific brood number of waterfowl and aquatic and terrestrial furbearers. In other instances, it was stated that increases in general bird and small mammal use would also occur. Annual wildlife censusing indicate the efforts of restoration have had some positive result by way of wildlife habitat, albeit relatively minor

In order to fully achieve the wildlife habitat objectives, restrictions on dog use in the project area, as well as the use by the general public is necessary. Leash laws should be enforced and educational signs/material posted to inform people of the wildlife objectives of the restoration project. Additional habitat features such as snags and logs could also be placed throughout the site for habitat enhancement. Large trees should be protected from beaver browse with metal screening. Given the urban setting of this restoration project, consideration should be given to further study of the interactions between wildlife and the recreational impacts associated with restoration projects in an urban environment.

INTRODUCTION

Overview

This report summarizes five (5) years of monitoring results for the Thornton Creek Habitat Restoration Project at Matthews Beach. Biological monitoring commenced in 1999 following project implementation in 1998. The purpose of this project is to reestablish natural ecosystem functions at the Thornton Creek mouth by restoring fish and wildlife habitat and wetlands. Results are semi-quantitative and partially rely on best professional judgment of biologists performing the reviews. Monitoring results are used as reference to determine how effectively the project achieved the project goals. Specific goals and objectives for this project are stated below. Monitoring protocols were performed for fish, invertebrates, vegetation and wildlife. A general summary of results and trends is included in separate sections for each discipline. Recommendations for the City of Seattle Parks Department for on-going adaptive management and maintenance are also stated.

The project was implemented in summer and fall 1998 at the City of Seattle's Matthews Beach Park. The park is located on the shoreline of Lake Washington at the mouth of Thornton Creek (See Figures 1,2, & 3). The project was undertaken by the U.S. Army Corps of Engineers (Corps) and its cost-sharing partner, the City of Seattle, Department of Parks and Recreation. This effort was authorized under Section 1135 of the Water Resources Development Act (WRDA) of 1986 for the Corps; the Seattle Parks and Recreation Department's authority was the Shoreline Parks Improvement Fund (SPIF).

Background

Prior to Lake Washington Ship Canal (LWSC) project development, Thornton Creek entered Lake Washington in a shallow gradient several hundred yards upstream of the present creek mouth. The old creek mouth area included extensive wetlands. Lowering of the lake level exposed more land to development and resulted in the loss of wetlands and shoreline habitat. This degradation includes the Matthews Beach Park area, which although a "green space", is relatively poor habitat compared to an undeveloped area. A section of this public park is the basis for the project.

The problems caused by the change in lake levels are part of an overall pattern of environmental impact caused by human development. The total stream length of Thornton Creek and its branches and tributaries is about 18 miles, virtually all in an urban setting. The basin is approximately 11.6 square miles, in northeast Seattle and the city of Shoreline. The creek flows into Lake Washington on its western shore, north of the upstream entrance to the Lake Washington Ship Canal (Figure 1). The Thornton Creek drainage in general is mixed with single-family houses, apartments, and heavy commercial/retail development in places, including Northgate Mall and Seattle's Northgate and Lake City commercial cores. High sediment loading and substrate compaction, loss of native riparian vegetation, bank erosion, channelization and bulkheading, culverting and other fish barriers, flashy runoff patterns, and contamination from street runoff have affected Thornton Creek. Biotic diversity has been severely affected.

Matthews Beach Park is in a moderate-density urban residential and commercial area in Seattle; housing near the park is mostly single-family dwellings, though some multi-unit apartment buildings are nearby. The park, where Thornton Creek flows into Lake Washington, consists largely of open lawn areas used by the public for picnicking. There is a beach used for swimming, north of the creek. The restoration site occurs on the south side of the creek mouth. Prior to implementation of the restoration plan, a concrete retaining bulkhead approximately three feet high was visible a long the Lake Washington shoreline. Trees and other vegetation comprised the site margins, with mowed lawn throughout most of the restoration area.

Goals and Objectives

Project goals were established to provide guidance in design of the restoration plan and provide criteria for which monitoring could be performed (USACE, 1996). The project goals are stated below. Each goal is followed by one or more objectives that indicate how the goal will be achieved.

- Restore native fish and wildlife habitat at Matthews Beach as much as possible within the project area while not increasing flood risk or risk to public safety
    - *Create rearing habitat for juvenile native (salmonid) fish in the form of a pond with surface inflow and outflow.*
    - *Restore native riparian habitat in defined habitat zones throughout most of the site*

- Provide wetland function at Matthews Beach in addition to what exists there now.
    - *Configure surface water bodies (Thornton Creek ,created pond, Lake Washington shoreline) to create wetland areas adjacent to them.*

- Remove non-native plants and restore the riparian plant community in the project area to a native assemblage as much as possible.
    - *Eliminate non-native riparian vegetation and replant with native species wherever possible in conjunction with other project features and along main channel.*

The goals and objectives stated above are addressed in the following sections of this report. The sections are by discipline, (1) Vegetation/Wetlands, (2) Fisheries, (3) Invertebrates, and (4) Terrestrial Wildlife.

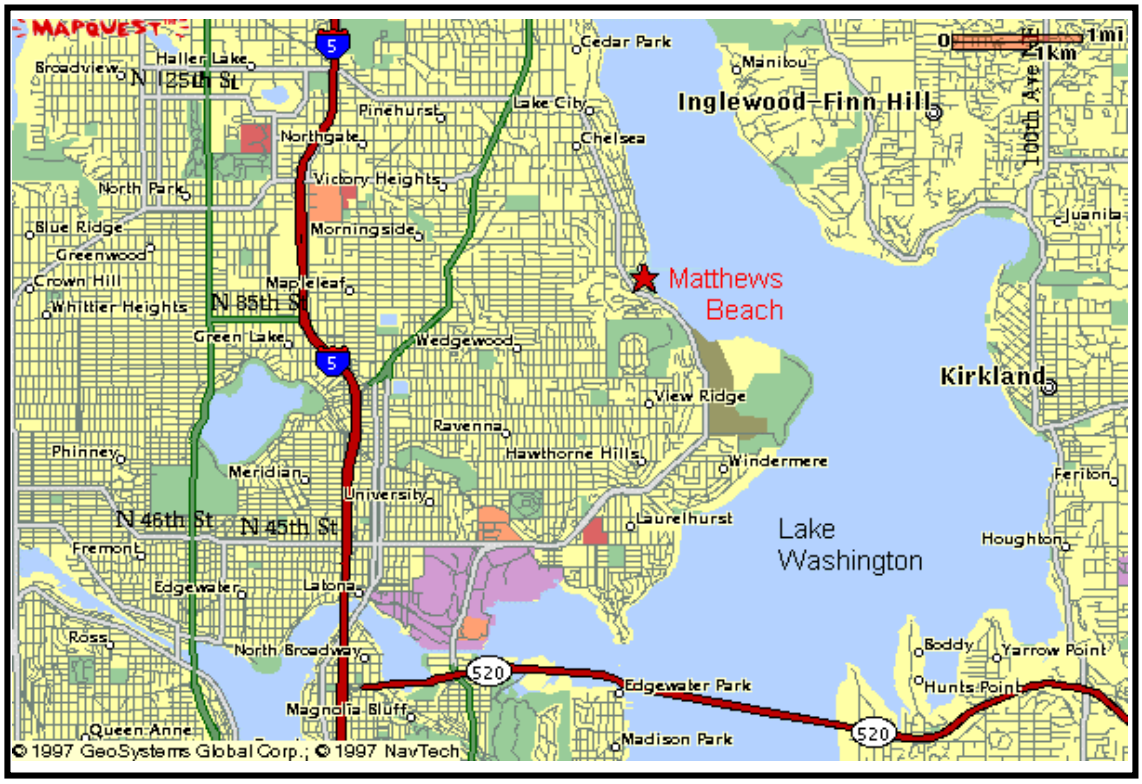

Figure 1. Vicinity Map. Project is within the City of Seattle, which is partially depicted to the west of Lake Washington.

Figure 2. Site Map

INSERT FIGURE 3 – Thornton Creek 1135 Habitat Restoration HERE

1. VEGETATION & WETLANDS

1.1 Overview

Vegetation monitoring was performed to measure the success of planting, presence and control of invasive species, and presence of volunteer species in the restoration area. Success of the planting effort was also used as the primary performance standard to determine success of the wetland creation/enhancement. The Landscape Plan (Figure 3) identifies five (5) planting zones for the site. The planting zones delineate each target habitat type. Habitat types include "shrubby-wetland zone," "forested wetland," "(extended) wildlife transition zone," "emergent wetland," and "shoreline enhancement zone." Habitat types were determined to maximize habitat diversity and to be suitable for the unique hydrology and soil conditions in the project area. However, at the time of installation, a deviation from the planting locations specified in the planting zones occurred. This was due to the highly disturbed site conditions exposed at the time of planting. Soils lacked topsoil, contained high clay content and drainage was poor. Professional judgment was used at the time of installation to place plant material in locations where they would have the highest probability of survival (Kunz, 2004).

1.2 Methods

Plants were planted fall 1998 with a subsequent planting event winter 1999 as part of the Corps' effort. It also occurred on various occasions following that under the organization of the Seattle Parks and Recreation Dept. and voluntarily by residents in the neighborhood Removal of invasive vegetation species also occurred on several occasions in that manner. Soil quality was poor; much of it consisted of dense clay. Mulching was done on various occasions as part of the overall planting effort.

Vegetation monitoring was performed over a four (4) year period in the growing seasons of 2000, 2001, 2002 and 2003. Permanent photo stations were established in 1999 to photo-document success of plantings and effectiveness of invasive species control (Davis, 1999). The observer used professional judgment to assess plant health and vigor. Observations of plant stress, presence of invasive species and volunteer species were noted. Results and recommendations were presented annually, in an in-house memorandum.

Tables 1-1 through 1-9 present the species of plants established in each identified habitat zone. The Abundance column lists the relative abundance of each species recorded in 2003 within each zone. Abundance is recorded as "Dominant" (D), "Common" (C), "Occasional" (O) or "Rare" (R). Abundance recorded only the species of the habitat zone strata; for example, herbaceous groundcover was not assessed in "shrubby wetland zone" since the target habitat class was shrubs. Similarly, understory vegetation was not recorded in "forested wetland zone" since the target habitat class was trees. Some identified species were recorded that were not planted as part of the Corps of Engineers planting efforts. These species may represent plants installed by the parks department, residents, or volunteer species.

1.3 Results & Discussion

Fall 1998 Plant Lists and Record of Abundance 2003. Reference Fig. 3 for zone locations.

Table 1-1. Wildlife Transition Zone A

Botanical Name/Common Name	**Abundance (2003)**
Fraxinus latifolia-Oregon ash	Rare
Alnus rubra – red alder	Occasional
Thuja plicata –western red cedar	Rare
Pseudotsuga menziesii- Douglas fir	Absent
Corylus cornuta – western hazel	Absent
Sambucus racemosa – red elderberry	Rare
Ribes sanguineum – red flowering currant	Rare
Gaultheria shallon – salal	Absent
Symphoricarpus alba – snowberry	Occasional
Rosa nutkana – Nootka rose	Occasional
Cornus sericia – red osier dogwood	Dominant
Salix lasiandra – Pacific willow	Dominant
Salix sitchensis – sitka willow	Occasional
Physocarpus capitatus – Pacific ninebark	Common
Populus trichocarpa – black cottonwood	Common
Pinus contorta – shore pine	Occasional
Salix scouleriana – Scoulers willow	Rare
Spiraea douglasii – hardhack	Rare
Lonicera involucrata – twinberry	Rare
Berberis nervosa – Oregon grape	Rare
Myrica gale – wax myrtle	Ocassional
Betula sp. – birch	Rare

Table 1-2. Wildlife Transition Zone (B)

Botanical Name/Common Name	Abundance (2003)
Fraxinus latifolia-Oregon ash	Rare
Alnus rubra – red alder	Dominant
Thuja plicata –western red cedar	Rare
Pseudotsuga menziesii- Douglas fir	Absent
Corylus cornuta – western hazel	Absent
Sambucus racemosa – red elderberry	Rare
Ribes sanguineum – red flowering currant	Absent
Gaultheria shallon – salal	Absent
Symphoricarpus alba – snowberry	Occasional
Rosa pisocarpa – peafruit rose	Occasional
Populus trichocarpa – black cottonwood	Common
Cornus sericia – red osier dogwood	Dominant
Salix lasiandra – Pacific willow	Occasional
Salix sitchensis – sitka willow	Occasional
Pinus contorta – shore pine	Rare
Lonicera involucrata – twinberry	Rare
Rosa nutkana – Nootka rose	Rare

Table 1-3. Wildlife Transition Zone (C)

Botanical Name/Common Name	Abundance (2003)
Fraxinus latifolia-Oregon ash	Rare
Alnus rubra – red alder	Occasional
Thuja plicata –western redcedar	Absent
Pseudotsuga menziesii- Douglas fir	Absent
Corylus cornuta – western hazel	Absent
Sambucus racemosa – red elderberry	Absent
Ribes sanguineum – red flowering currant	Absent
Gaultheria shallon – salal	Absent
Symphoricarpus alba – snowberry	Absent
Populus trichocarpa – black cottonwood	Occasional
Salix lasiandra – Pacific willow	Rare
Pyrus fusca - crabapple	Rare
Rosa nootkana – Nootka rose	Rare
Cornus sericia – red-osier dogwood	Occasional
Lonicera involucrate - twinberry	Rare
Spiraea douglasii - hardhack	Rare
Salix sitchensis – Sitka willow	Occasional
Salix alba var. tristis – weeping willow	Rare
Myrica gale – wax myrtle	Rare

Table 1-4. Shrubby Wetland Zone (A)

Botanical Name/Common Name	Abundance (2003)
Vaccinium parvifolium – red huckleberry	Absent
Cornus sericia – red osier dogwood	Common
Lonicera involucrata – black twinberry	Absent
Spiraea douglasii – Douglas spiraea	Absent
Rosa nutkana – nootka rose	Absent
Salix spp. – native shrub willow	Ocassional
Rubus parviflorus – thimbleberry	Absent
Rubus spectablilis – salmonberry	Absent
Physocarpus capitatus – Pacific ninebark	Ocassional
Fraxinus latifolia – Oregon ash	Rare
Myrica gale – sweet gale	Common
Betula sp. – birch	Rare
Populus trichocarpa – black cottonwood	Common

Table 1-5. Shrubby Wetland Zone (B)

Botanical Name/Common Name	Abundance (2003)
Cornus sericia – red osier dogwood	Dominant
Lonicera involucrata – black twinberry	Ocassional
Physocarrpus capitatus – Pacific ninebark	Common
Rosa nutkana – nootka rose	Common
Populus tremuoides – quaking Aspen	Rare
Thuja plicata – western red cedar	Rare
Crataegus douglasii – hawthorne	Rare
Symphoricarpos albus – snowberry	Rare
Vaccinium parvifolium – red huckleberry	Absent
Spiraea douglasii – hardhack	Absent
Salix sitchensis – sitka willow	Common
Salix lasiandra – Pacific willow	Occasional
Rubus parviflorus – thimbleberry	Absent
Rubus spectabilis – salmonberry	Absent

Table 1-6. Shrubby Wetland Zone (C)

Botanical Name/Common Name	Abundance (2003)
Cornus sericea – red osier dogwood	Rare
Lonicera involucrata – black twinberry	Absent
Vaccinium parvifolium – red huckleberry	Absent
Spiraea douglasii – hardhack	Absent
Salix lasiandra – Pacific willow	Dominant
Salix sitchensis – sitka willow	Dominant
Populus trichcocarpa – black cottonwood	Common
Alnus rubra – red alder	Common
Myrica gale – sweet gale	Occasional
Fraxinus latifolia – Oregon ash	Occasional
Rubus parviflorus – thimbleberry	Absent
Rubus spectabilis – salmonberry	Absent

Table 1-7. Forested Wetland Zone

Botanical Name/Common Name	**Abundance (2003)**
Alnus rubra – red alder	Common
Fraxinus latifolia – Oregon ash	Rare
Thuja plicata – western redcedar	Rare
Salix sitchensis – Sitka willow	Dominant
Salix lasiandra – Pacific willow	Common
Populus trichocarpa – black cottonwood	Common
Pinus contorta – shore pine	Rare
Acer macrophyllum – big leaf maple	Rare

Table 1-8. Emergent Wetland Zone

Botanical Name/Common Name	**Abundance (2003)**
Carex obnupta – slough sedge	Rare
Scirpus microcarpus – small-fruited bulrush	Dominant
Juncus effusus – soft rush	Common
Iris pseudacorus – yellow iris	Occasional
Salix sp. – native willow	Dominant

Table 1-9. Shoreline Enhancement Zone

Botanical Name/Common Name	**Abundance (2003)**
Alnus rubra – red alder	Occasional
Fraxinus latifolia – Oregon ash	Rare
Salix lasiandra – Pacific willow	Dominant
Salix sitchensis – Sitka willow	Common
Populus trichocarpa – black cottonwood	Occasional
Cornus sericia – red osier dogwood	Occasional

City Parks Department installed some additional plants in autumn 2002 (Denovan, R, 2004). A complete list of species, numbers and locations is not available, however personal communication with the City parks gardener confirmed the general planting locations and species. The plantings are located adjacent to the kiosk and access trail in the Expanded Wildlife Transition Zone. Compost and a heavy wood chip mulch were also applied. Species observed include rhododendron (*R. macrophyllum*), Oregon grape (*Mahonia nervosa*), evergreen huckleberry (*Vaccinium ovatum*), piggy-back (*Tolmiea menziesii*), salal (*Gaultheria shallon*), deer fern (*Blechnum spicant*) and sword fern (*Polystichum munitum*). In addition, a number of native flowering herbs and forbes were planted along the trail to create a more park-like setting. Most recorded species appear in good health.

An Army Corps of Engineers student intern prepared an invasive vegetation report (Davis, 1999) to address invasive species issues on this site. The report outlines control methods for identified invasive species. Species of concern include purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Polygonum cuspidatum*), Himalayan blackberry (*Rubus discolor*) and morning-glory (*Convolvulus soldanella*). Manual control of invasive species include cutting, pulling, digging, and raking seeds. Black tarp treatments were also used to cover some invasive species along the Thornton Creek channel. Treatment effectiveness was evaluated during annual monitoring events.

Each planting zone contained a different assemblage of species based on site conditions. The following summary applies to all planting zones, with the exception of the Expanded Wildlife Transition Zone C. The Wildlife Transition Zone C has experienced a high degree of plant mortality. Surviving vegetation appears stressed due to the hydrologic conditions resulting from poor soil. Zone C has a curious assemblage of species. Soft rush (*Juncus effuses*-Facultative-Wetland) and common pasture grasses are abundant, with occasional cover of small-fruited bulrush (*Scirpus microcarpus*-Obligate). The majority of the planted sitka willow (*Salix sitchensis*-Facultative - Wetland) are dead or stressed, presumably from dry ground conditions and disease (rot). Although hydrology was not monitored, surface-soil conditions indicate this is a very dry environment. The planted woody vegetation prefers a wetter environment for survival. The herbaceous groundcover may be responding to seasonally saturated conditions in a shallow surface layer.

The remainder of the vegetation in the planting zones is establishing well, perhaps in spite of the heavy clay composition of the underlying soil. Cover of trees, shrubs and herbaceous vegetation is robust. Most plants appeared in reasonably good health, with minimal indication of plant stress or isolated occurrence of mortality. Since planting, there has been a shift in some targeted plant communities. Projected planting zones are establishing as hoped (Figure 3); however the assemblage has shifted due to some mortality of certain species. There is presently little cover of Oregon ash (*Fraxinus latifolia)* and coniferous trees. The intended forest and shrub class is more dominated by black cottonwood, sweet gale, willows and volunteer red alder. Functionally, the established habitats are desirable and generally performing the same habitat functions as those specified.

Emergent communities around the pond are somewhat sparse due to encroachment of adjacent woody vegetation. However, within the created channel, a robust emergent community occurs. At the Thornton Creek top of bank and riparian zone, dead *Salix* stakes were observed from previous planting efforts. As noted in the 2001 monitoring results, this planting effort was not successful. High mortality could be attributed to pedestrian use of this area. Non-designated footpaths for lake access are present at the mouth of the pond and along the top of bank. The dead stakes also appear to be set back too far from the creek and may not be in a wet enough environment.

The presence of invasive species has been significantly reduced in the non-submersed habitats. Species of concern identified by Davis (1999) include purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Polygonum cuspidatum*), Himalyan blackberry (*Rubus discolor*) and morning-glory (*Convolvulus soldanella*). All species are invasive; however purple loosestrife is a state listed Noxious weed and particularly aggressive in wetland and shoreline environments (King County, 2002). Based on previous years' monitoring results, it appears that these problem species are being effectively controlled. At the Thornton Creek channel, there is a small population of Japanese knotweed remaining in the northwest corner of the site. The infestation area appears significantly smaller than described in other reports, and was only about 2' –3' high at the time of study. This indicates someone is regularly cutting it down, since left unattended that species would be at least twice that height by 13 August. Purple loosestrife has significantly less cover than described and documented in previous reports. Single specimens remain in areas where smaller infestations were recorded. In some locations, I was unable to locate a single specimen in areas that were previously infested. The filter cloth used to suppress it was left in place at least three years, though it was originally intended for only 1-2 years.

Davis (1999) did not identify or address a highly problematic aquatic species, Eurasian watermilfoil (*Myriophyllum spicatum*) that has infested the fish rearing pond. Eurasian watermilfoil is a Noxious Weed of the State of Washington as it chokes out native plants and beneficial vegetation, alters fish and wildlife habitat, lowers dissolved oxygen levels and raises water temperature (King County, 2002). According to Seattle District USACE biologists, the infestation appears new and may not have been present at the time of the 1999 study. As of July 2003 the entire pond was thick with this species. Waterfowl can act as a vector, transporting minor fragments of milfoil from Lake Washington where it can quickly take over an un-infested habitat.

1.4 Conclusions

The planted vegetation on this site is establishing well. Those species that did not survive are likely too sensitive for the poor soil conditions, or not suited (too dry) to the placement location. Nevertheless, high survival of most species, and volunteer native regrowth, has established adequate cover and diversity to achieve the projected habitat types for this site. There is indication that some trees on the site have been intentionally killed. The motive is likely by a resident(s) to maintain view corridors. Maintenance of view corridors is an agreed upon maintenance task as specified in the Project Cooperation Agreement with the City of Seattle Parks Department.

Wildlife Transition Zone (C) has experienced significant mortality of vegetation and should be re-planted. To deter the dense herbaceous growth, the soil should be augmented with an organic sheet mulch. Tree and shrub species should be revised from the original specifications to a dryer assemblage more tolerant of poor soil conditions. Suggested species include shore pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*), Scouler's willow (*Salix scouleriana*), oceanspray (*Holodiscus discolor*), and/or snowberry (*Symphiocarpos albus*). Given the relatively small planting area, larger plant material in up to 5-gallon containers should be utilized. Zone 8 should be irrigated regularly for a period of 3 years during the summer months following installation. As of September 2003, temporary irrigation was in place in this area. The Seattle Parks Department, as project sponsor, is responsible for this maintenance task (or any agreed-upon alternative). A planting plan developed for this region should consider maintaining the view corridors to the lake shoreline.

Previous willow plantings on the banks of Thornton Creek have failed. Given the significant benefit from achieving this habitat cover, it is recommended to replant this area. Greater planting success may occur from placing containerized plants about one foot back from the top of bank. Species such as vine maple (*Acer circinatum*) and Pacific ninebark (*Physocarpus capitatus*) would be suitable. Red-osier dogwood (*Cornus sericea*) and willows (*Salix* spp.) could be tried again at the top of bank. Containerized plants (1 gallon) at the top of bank may survive better than the previous planting of cuttings mid-slope. The Thornton Creek channel could be planted concurrently with Wildlife Transition Zone (C).

Presently, invasive species appear to be under control and the existing maintenance program appears effective. Regular cutting and removal of Japanese knotweed and purple loosestrife should continue as needed. Given the nature of these species, a control program is a more realistic goal than eradication. More aggressive control treatments could be implemented to reduce long-term maintenance needs. Control treatments could include removal of the above-ground plant material, placement of an organic interface (3 layers of cardboard), cover of topsoil, and 6 to 10 inches of wood chips. The area could be planted with containerized material following initial decomposition of the sheet mulch.

Eurasian milfoil needs to be aggressively controlled in the fish rearing pond. Given the size of the area, non-chemical treatment methods should be utilized. The most appropriate control technique is manual removal (Hamel, 2003). Removal should be performed by divers in the early part of the growing season (May) when the below-water growth is approximately 1 foot in length (Kerr, 2003). Early in the growing season the plant is not as brittle, which reduces the tendency for the plant to fragment and spread. Manual removal should occur annually.

1.5 Recommendations

- Maintain view corridors to permit residential lake views and discourage delinquent after-hours activities. Proper maintenance by Seattle Parks Department may discourage residents from intentionally killing trees for view and surveillance purposes.

- Selectively thin volunteer red alders where dense regrowth is occurring.

- Replant Wildlife Transition Zone (C) with a more suitable assemblage of species for the unique soil and water conditions in that zone. Creating microtopography could help achieve this. The soil should also be augmented with organic mulch to improve soil structure, water-holding capacity and provide nutrients. Irrigation should occur regularly following planting for a period of 3 years.

- Non-invasive ornamental trees or shrubs could be considered for locations that native species establish poorly. The plants could be transitioned from the maintained park area to the more naturalistic restoration zones.

- Replant the Thornton Creek Riparian Corridor (Shrubby Wetland Zone A) with different placement of willows and other understory native shrubs.

- Continue invasive species manual control.

- Eurasian milfoil should be hand-removed by divers annually in the early growing season from the fish pond. On-going monitoring should occur to determine the duration of annual maintenance.

2. FISHERIES

2.1 Overview

The Matthews Beach Restoration project included creation of a juvenile fish (salmonid) rearing pond. The purpose of the restoration feature was to create rearing and refuge habitat for juvenile salmonids. The pond was not intended to be stocked, but rather was intended for volitional use by juvenile salmon from adjacent Thornton Creek. Creation of the pond would provide protected rearing areas during Thornton Creek low and high flows, as well as provide refuge from adult predatory fish such as cutthroat trout (*Onchorhynchus clarki*), bass (*Micropterus sp*.) and northern pikeminnow (*Ptychocheilus oregonensis*). The target species were juvenile coho salmon (*O. kisutch*) and cutthroat. However, the pond could also provide suitable habitat for juvenile rainbow trout (*O. mykiss*), steelhead, Chinook salmon (*O. tschawytscha*), and sockeye salmon (*O. nerka*), although the latter are probably more suited to the open water of the lake once they are no longer stream-dependent.

The design included construction of a fish rearing pond fed by a diverted natural stream channel. The pond is approximately 3,500 square feeet in size. A stormwater and groundwater fed surfacewater spring-fed stream was diverted from the south side of the property, in a more natural channel alignment to feed the created pond area. The pond was excavated from upland, achieving depths of 5-7 feet with shallow gradient side slopes. A clay layer was placed for the pond bottom. Boulders and woody debris were also placed. To create the impoundment, a naturalistic weir was constructed of logs, clay and rocks at the outlet leading to Thornton Creek. Following construction, the pond perimeters and buffer were planted with native emergent and woody vegetation. Sedimentation ponds were incorporated into the stream design upstream of the main rearing pond to trap stormwater fed sediments before they entered the rearing pond. They were lined with cobbles to provide a lower limit for sediment removal.

2.2 Methods & Materials

The purpose of the monitoring was to document use of the fish-rearing pond by target species of juvenile salmonids. Monitoring was performed two to four times per year over a five-year period (see Tables 2-1 to 2-4 for collection dates). Sampling occurred once every season throughout the year when time and funding permitted. In 2001, two sampling seasons were lost due to an extended delay obtaining a Sec. 10 permit under the Endangered Species Act to allow sampling of threatened Chinook salmon. We designated winter as January, February, and March; spring as April, May, and June; summer as July, August, and September; and fall as October, November, and December. One sample period equaled one day. Starting with the fourth sampling date the pond was seined two to five times during a sample period, depending on how many salmonids were recaptured during each set.

A beach seine or a pond seine was used to capture fish. The seining was done by two or three people. One person took one end of the net out across the pond to the other side, by walking around the pond with the hauling line and then pulling the net straight out across the pond so that it was fully extended in the water. Care was taken to make sure not to get the net twisted or sunk

in the process, and then the two ends of the hauling lines would be gathered by the people holding each hauling line walking toward each other along the banks of the pond. Once the two ends of the lines were brought together the net would be pulled in slowly to the shore until the bag of the net was reached. This process pushes the fish that are caught in the net into the bag of the net where they cannot escape until released. Approximately half the area of the pond was sampled in this manner for each set.

Once trapped, fish were placed in one of three buckets filled with water from the pond for species identification and measurement. The first bucket was used to store the fish until it was time for them to be sedated. The second bucket was for sedating, and the third bucket was used for recovery of the fish before release.

The fish were sedated with MS222 for measuring and marking to eliminate excess stress. While the fish were sedated, a millimeter ruler was used to measure the fork length of the fish and either hand clippers or surgical scissors were used to fin clip the salmonids (upper or lower lobe of the caudal fin) for identification of recaptures in later sets. Fish were only identified and counted on the first three collection dates; none were marked or measured. Starting 12/3/99 salmonids were marked for recapture identification and measured in mm., if time permitted.

Recapture data was also collected so that population estimates could be figured for each species of salmonids that utilize the pond. The method that was used to figure the population estimates is a modified version of the Lincoln-Peterson method. The formula that was used was $N=M(C+1)/(R+1)$. In this instance N = the estimated population, M = the number of fish that were captured and marked in previous sets, C = total fish captured in the final set, and R = number fish that were recaptured in the final set. This revised form of the Lincoln-Peterson method was used because it accounts for having small sample and population sizes.

2.3. Results

Tables 2-1 through 2-4 present the results of five years of monitoring at the Thornton Creek pond. A table is provided for each species, coho, Chinook, cutthroat and other. Each table includes:

- date of sample
- water temperature
- mean fork length of captured fish
- range of fork length
- population estimate
- percentage of total sample that was made up by this species

Table 2-1. Population Numbers For **Coho**

Date	Water Temp (°C)	Coho (*O. kisutch*)			
		Mean length of fish (mm)	Range of length (mm)	P. Est.	% of Salmonid Pop. consisting of coho
5/12/1999	12.8				
9/8/1999					
9/10/1999					
12/3/1999					
3/29/2000	8.40	138	138	1	1
9/12/2000		0	0	0	0
12/8/2000		0	0	0	0
9/12/2001	15.00	92.8	74-198	450	87
12/27/2001	8.00	98.1	75-123	612	66
2/27/2002	7.00	101.7	78-125	75	69
6/27/2002	16.00	73.5	51-86	156	94
9/4/2002	14.00	94.9	80-112	264	87
12/24/2002	8.00	103.6	76-126	200	41.9
3/20/2003	10.00	107.4	90-120	12	18
5/22/2003	14.00	0	0	0	0
7/22/2003	18.00	0	0	0	0

Table 2-2. Population Numbers For **Chinook**

Date	Water Temp (°C)	Chinook (*O. tschawytscha*)			
		Mean length of fish (mm)	Range of length (mm)	Pop. Est.	% of Salmonid Pop. consisting of Chinook
5/12/1999	12.8				
9/8/1999					
9/10/1999					
12/3/1999					
3/29/2000	8.40	132	130-145	6	6
9/12/2000		143.5	135-152	2	2
12/8/2000		0	0	0	0
9/12/2001	15.00	89.4	73-113	25	5
12/27/2001	8.00	93.4	84-102	15	2
2/27/2002	7.00	0	0	0	0
6/27/2002	16.00	91.4	86-95	8	5
9/4/2002	14.00	113.5	101-126	2	1
12/24/2002	8.00	110	110	1	0.2
3/20/2003	10.00	0	0	0	0
5/22/2003	14.00	0	0	0	0
7/22/2003	18.00	0	0	0	0

Table 2-3. Population Numbers For **Cutthroat**

Date	Water Temp (°C)	Cutthroat (*O. ckarki*)			
		Mean length of fish (mm)	Range of length (mm)	Pop. Est.	% of Salmonid Pop. consisting of cutthroat
5/12/1999	12.8				
9/8/1999					
9/10/1999					
12/3/1999					
3/29/2000	8.40	144.6	125-186	91	93
9/12/2000		124.5	56-178	107	98
12/8/2000		142.4	77-245	347	100
9/12/2001	15.00	110.6	83-190	42	8
12/27/2001	8.00	105.1	73-200	297	32
2/27/2002	7.00	109.3	86-180	33	31
6/27/2002	16.00	115	115	1	1
9/4/2002	14.00	89.7	70-182	37	12
12/24/2002	8.00	87.1	60-189	276	57.9
3/20/2003	10.00	101.2	75-195	49	82
5/22/2003	14.00	115.2	82-152	34	100
7/22/2003	18.00	122	122	1	100

Table 2-4. Number Of **Other Species** Captured

Date	Water Temp (°C)	Rainbow Trout (*O. mykiss)*	Sculpin (*Cottus* sp.)	Stickleback (*Gasterosteus aculeatus*)	Lamprey (*Lameta*)	Peamouth (*Mylocheilus caurinus*)	Pumpkin seed (*Lepomis gibbosus*)	Largescale Sucker (*Catostomus macrocheilus*)
5/12/1999	12.8	0	0	1	0	0	0	0
9/8/1999		0	120	51	6	8	2	0
9/10/1999		0	46	1	1	4	0	0
12/3/1999		2	1	0	0	0	0	0
3/29/2000	8.40	0	1	0	0	0	0	0
9/12/2000		1	63	7	0	0	0	0
12/8/2000		0	12	0	0	0	0	0
9/12/2001	15.00	0	0	2	0	0	0	0
12/27/2001	8.00	0	7	1	0	0	0	0
2/27/2002	7.00	0	0	0	0	0	0	0
6/27/2002	16.00	0	2	154	0	0	0	0
9/4/2002	14.00	0	0	0	0	0	0	0
12/24/2002	8.00	0	25	28	0	0	0	0
3/20/2003	10.00	0	6	10	0	0	0	0
5/22/2003	14.00	0	85	210	0	0	0	1
7/22/2003	18.00	0	10	200	0	0	0	0

Coho and Chinook were planted in the pond during the summers of 2001 and 2002 by the Seattle Public Utilities Salmon in the Classroom program (Stinson, 2001). These events altered the natural population numbers intended for sampling as part of this study. Prior to planting, the 2000 coho and Chinook population was zero, and the juvenile cutthroat population was 107. Yet in the summer of 2001 the juvenile cutthroat population was only 42 while the juvenile coho population was 450 fish and the juvenile Chinook population was 25 individuals. The same trend is seen through the fall of 2002. Once coho and Chinook were no longer being planted, the 2003 data indicates the number of coho and Chinook quickly declined to zero. Subsequently, by the spring of 2003 the population for cutthroat increased by 33 fish.

Other species of fish that were captured in the pond while sampling are rainbow trout, sculpin, stickleback, lamprey, peamouth, pumpkinseed, and largescale sucker. Rainbow trout were seen in the pond only in December 1999 and September 2000. Sculpin were first seen in September 1999 and were captured throughout the monitoring. Their numbers ranged from 1 to 120 fish. Sticklebacks were consistently recorded from the first sample in May 1999 to the last sample in July 2003. Their numbers were between 1 and 200 and were generally increased over the five years of monitoring. Lamprey, peamouth, and pumpkinseed were captured in the pond only in September 1999 and then were not seen again. One largescale sucker was captured in May 2003. This shows that the only non-salmonid species that uses the pond consistently are sculpin and stickleback. Population estimates were not conducted for non-salmonids.

Incidental to the fish sampling, crayfish (*Pacifastacus* sp.) were captured in September 1999 and May and July 2003.

2.4. Discussion

The primary goal of this project was to create rearing and refuge habitat for juvenile fish with an emphasis on salmonids. The results of the monitoring indicate that the goal has been achieved for cutthroat trout, sculpins, stickleback, and may be achieved for coho salmon. The numbers of cutthroat in the pond declined slightly in 2003, however, this could be due to several factors including natural carrying capacity or other environmental factors. In the last two years of monitoring (2002, and 2003) the pond has accumulated large quantities of sediment while Eurasian milfoil and filamentous algae have become abundant. It would be reasonable to assume that the increase in sediment and the decaying aquatic vegetation is influencing the salmonid populations by reducing suitable habitat for many species of benthic invertebrates and increasing the oxygen demand of the pond.

As shown in Table 3-3, large numbers of juvenile cutthroat trout have been found to be utilizing the pond. Sampling conducted in December of 2000, 2001, and 2002 resulted in an estimated population of approximately 300 fish each year. This suggests that the pond is providing quality rearing habitat for juvenile cutthroat trout. In addition, the increase in the number of cutthroat redds found in Thornton Creek suggests that the pond is enhancing the adult spawning population in the creek (Appendix A). It must be remembered, however, that cutthroat are more tolerant of urban conditions than salmon are. The presence of cutthroat in large numbers in the pond should not be considered conducive to use of the pond by the salmon species.

Although coho do not appear to be utilizing the pond through volitional means the Corps believes that if coho were having greater spawning success in Thorton Creek, juvenile coho would benefit from the project much like cutthroat have. This is supported by the large numbers of coho that were captured during 6 sample periods in 2001 and 2002. It is known that these coho were planted but they were found utilizing the pond for several months after planting and they appeared to be in very good condition. The Corps believes that coho are not being excluded from the pond due to passage problems but they are simply not finding the pond as they are not present in sufficient number in the area in the early spring when juvenile coho would typically move into a pond for rearing. Sampling of outmigrating fish by the Washington Dept. of Fish and Wildlife and the Seattle Public Utilities Dept. a few hundred yards upstream in Thornton Creek has recorded few coho or Chinook outmigrants, even in comparison to other streams in the developed areas around Seattle. Other issues in the watershed will need to be addressed for the restoration area rearing pond to achieve its full potential.

It is theorized that coho are spawning during the fall when flows in Thornton Creek are very low and water temperatures are high, reducing spawning success. The small number of redds that are produced are then subject to high flows during the winter that can either scour or deposit substrate on these redds, severely reducing any production. Therefore, if coho are not being produced in Thornton Creek, it would be very unlikely that coho fry would find the pond and utilize it. Not only does this scenario reduce the possibility of juvenile coho finding and using the pond, it is now believed that many of the adult coho entering Thornton Creek are not surviving long enough to spawn (K. Lynch, 2004). Based on the increase in numbers of cutthroat redds in 2002 and 2003, the pond appears to be enhancing the population of cutthroat in Thornton Creek (Appendix A). If spawning and rearing habitat were improved in Thornton Creek, the pond would most likely increase coho production as well.

2.5 Conclusions

The monitoring of Matthews Beach rearing pond shows that cutthroat are the primary species of salmonids that naturally utilize the pond. Only a small number of Chinook were captured in the pond and the majority of these were caught during 2001 and 2002 when they were being planted. In a similar trend, coho populations have declined to zero following termination of pond stocking. The lack of a naturally occurring coho population could be attributed to a number of factors. A probable reason for coho absence is that coho may not be successfully spawning in Thornton Creek (Fisheries Consultants, 2003). Therefore there is a limited juvenile population of coho to utilize the rearing pond. Sedimentation and aquatic weed infestation (Eurasian milfoil) may also be affecting overall habitat quality for juvenile fish.

2.6 Recommendations

- The sponsor should at least annually vactor the sediment pond to reduce sedimentation.

- Perhaps encourage the planting of coho in the pond through the Salmon in the Classroom program if the spawning success in Thornton Creek cannot be improved.

- Control algae and Eurasian milfoil within the pond (See Vegetation Discussion 1.4)

- Water quality monitoring is recommended to determine if unusually high concentrations of phosphates, nitrates, and total carbonate are contributing to the growth of filamentous algae. Protocols similar to those used by the US Geological Survey to sample in Puget Sound lowland streams, including Thornton Creek, could be applied.

- Promote the growth of large riparian vegetation adjacent to the pond to aid in cooler water temperatures and deter algae growth. It was intended that willows would grow up around the pond margins for this purpose, but some have been removed, possibly by private citizens, or by Parks maintenance personnel not fully instructed on the purpose of the vegetation. It will take vigilance to ensure that private citizens are not wantonly destroying vegetation around the pond or anywhere else on the project site.

3. INVERTEBRATES

3.1 Overview

Benthic monitoring was performed annually in a diverted Thornton Creek tributary at Matthews Beach Park. Water feeding the created stream reach originated as one of many small springs from the hillsides above Lake Washington, and previously bypassed Thornton Creek and fed directly to Lake Washington at the south end of the project area. Flow in this stream is perennial, and typically less than one cubic foot per second. In storms its flow may multiply to several cubic feet per second, though that has not been directly measured. The purpose of the stream diversion was to supply water to a created fish rearing pond adjacent to the Thornton Creek channel. The fish rearing pond was to provide off-channel rearing so as to protect coho fingerlings from predatory fish and be used by juvenile cutthroat. The purpose of benthic invertebrate monitoring was to assess the presence of invertebrates as biological indicators of overall stream health.

3.2 Methods

Two samples were taken per year in the stream that had been diverted to feed the fish pond. Seasonal timing of sampling varied throughout the monitoring period from spring, mid-summer and late summer. The individual samples were taken using a one-square-foot Surber sampler with 500-micron mesh size. All the stones inside the frame were turned over and hand rubbed to dislodge any organisms that may have been clinging to them. The contents were collected in the Surber net and deposited in an 8-ounce plastic container with ethyl alcohol added. Upon completion of the 5-year monitoring period, the collected samples were sent to Aquatic Biology Associates, Inc. for bug identification and analysis. The following is a summary of their findings.

INSERST TABLE 3-1 HERE

3.3 Results & Discussion

Table 3-1presents the benthic invertebrate abundance at the Thornton Creek Restoration project. The total number of taxa varied from 9 to 27. Richness peaked in September 1999. By May 1999 about half the average number of taxa had appeared. Richness remained moderate to high in 2000, but a declining trend is apparent through 2001 to 2003. This could be attributed to extended drought conditions. Most Seattle area urban streams have 20-40 taxa, so the total richness seen here is relatively low.

Most Seattle area urban streams will have 500-5000 total abundance of individuals per square meter (Wisseman, 2003). Abundance by May 1999 was high (4315-11400/m2), primarily from midge taxa that are able to colonize new substrate quickly. Abundance in September 1999 was moderately high (3712-3798). Abundance in September 2001 was low (549-689).

Taxa richness is indexed using the insect orders Ephemeroptera, Plecoptera and Trichoptera, often referred to as "EPT." These orders are known respectively as mayflies, stoneflies, and caddisflies, three insect orders that tend to be characterized predominantly by intolerant taxa and cold-water biota. EPT richness was very low from 1999-2003 (0-3 taxa). Richness of 10-30 EPT taxa would be expected in Seattle area urban/suburban streams with at least a moderate gradient and some cobble substrate (citation?). EPT taxa richness is always lower in low gradient streams with finer substrates, but 0-3 taxa is very low even for a low gradient stream. It wasn't until September 1999 that 2-3 EPT taxa were present. Then again, by 2000 they were absent.

During initial colonization in 1999 insects dominated the stream. However, after 1999 insect percentages were generally low. The September 2000 and particularly the July 2003 samples show a large disparity in the percent non-insects/insects between the Upper and Lower stations.

Invertebrates are divided into feeding groups. Organisms that collect fine organic particles off substrates (collector-gatherers) were dominant. Very few scrapers or shredders were present. Omnivore taxa were added to the collectors in this study since the particular omnivore taxa involved were primarily collectors. Collector-filterers' abundance and richness was generally low.

Percent 3 dominant taxa is a simple measure of diversity or evenness of the benthic invertebrate community. It adds up the percent contribution of the 3 most dominant taxa. Substrate disturbance communities or low habitat complexity lead to dominance of communities by a few taxa. Dominance >75 percent by the 3 most numerous taxa is considered high. Percent 3 dominant taxa at the Thornton Creek restoration site varied from 69-92 percent.

Tolerance refers to an organism's ability to withstand low dissolved oxygen, higher water temperatures and nutrient enrichment. All taxa present display moderate to high tolerance. The richness and abundance of highly tolerant taxa was generally low, indicating that excessive

nutrient enrichment or eutrophication is not a problem. There were no intolerant taxa or cold-water biota present. Their presence wouldn't be expected in a low elevation, low gradient, relatively open and warm, urban stream.

Taxa displayed some differences in how quickly they colonized the restored stream channel. Of particular note is the near absence of any insects besides chironomid midges in May 1999. By September 1999 notably more insect taxa appeared. However, some of these taxa did not persist in the stream after 2000.

Long-lived taxa require greater than 1 year to complete their life cycle. The only long-lived taxon to appear was *Lara avara*, a wood eating beetle. This was only one specimen in September 2001. The rest of the taxa are short-lived, most having multiple generations in a year.

Given these results, it is difficult to say that invertebrate production in the stream is supporting the juvenile fish in the rearing pond, despite the large numbers of the fish. Whether that is an issue needing attention is also difficult to say without further discussion and perhaps some study designed specifically to address food resource use by the fish.

3.4 Conclusions & Recommendations

Given the limited sampling and seasonal differences in sample collection, only very general interpretations can be obtained from these results. Samples were taken in May, July, and September, which can make a significant difference in the seasonal phenology of the benthic invertebrate community. Overall, the benthic invertebrate community that has developed in this restored stream segment appears to be one found generally in lower gradient streams on finer mineral substrates. It is possible that the significant variations in taxa richness and abundance can be correlated to flow and the hydrograph of the individual water years, drought and flood for instance. Specific solutions for low richness and diversity may be elusive in an urban environment, assuming action is desired by the project sponsor.

The large numbers of fish in the pond appear to be supported reasonably well; if the sponsor wants to learn more about the trophic structure which they rely on, it may wish to commission its own study.

5. WILDLIFE

5.1 Overview

In 1996, when the Thornton Creek Section 1135 Habitat Restoration Project was first authorized, a Wildlife Benefit Analysis was done identifying among other things, the existing conditions of that year. It was stated that Thornton Creek and its surrounding habitat at Matthews Beach Park minimally supported wildlife. It further went on to say that the existing buffer strip was too narrow and sparsely vegetated, and was dominated by exotic plant species, essentially making the habitat unattractive to most wildlife species. The proposal put forth in the restoration plan for wildlife was to enhance the surrounding habitat to attract, in some cases, a specific brood number of waterfowl and aquatic and terrestrial furbearers. In other instances, it was stated that increases in general bird and small mammal use would also occur.

From 1999 through 2002, a cursory one-day annual survey was conducted to document what species were present in the Thornton Creek area. In 2003, a four-day survey was conducted in an attempt to document species' presence, variation, and use over consecutive days.

5.2 Methods

From 1999 through 2002, a cursory one-day survey was conducted on-site to record all species present through aural and visual observations (real-time sightings, tracks, scat, and other signs indicating a species' positive identification). In year 1 & 2, the area of Matthews Beach Park that had not been restored as part of the project was used as a reference site in an attempt at comparing species richness. However, in years 3 & 4, the reference site was not used because it was not known to the new observer. Finally, in 2003, a four-day survey occurred. Under this survey and in addition to the previous years' surveys, four track plots were established throughout the project area in an attempt to document species use by track identification.

The surveys were conducted by the observer randomly walking the project site, usually early in the morning, recording species as they were observed. In years 1, 2, & 3, species were individually recorded (i.e., 5 starlings); whereas in year 4, species were recorded only once per day (i.e., starling).

No attempt was made to determine species population, nesting success, or reproduction efforts on site. Simple species presence was recorded with ancillary remarks of species activities.

5.3 Results & Discussion

In year 1, the survey was conducted on June 4, 1999 from 0535 – 0625 under cloudy conditions with the temperature approximately 50°F. Fourteen species of birds were observed in the project site and 6 species in the reference site (unrestored Matthews Beach Park), 5 of which were of the same species observed in the project site (Table 1). An additional 5 species of birds were observed just off-site or on Lake Washington. No data was collected on the activities of these species other than their presence.

In year 2, the survey was conducted on July 17, 2000 from 0700 – 0830 under clear skies with the temperature approximately 60°F. 14 species of birds were observed on-site, in addition to 3 river otters (1 adult, 2 juveniles) in Thornton Creek adjacent to the pond's outlet. 5 species of birds were observed at the reference site, 1 which was of the same species observed at the project site (Table 1). No data was collected for any of the bird activity, but information was noted on the behavior of the river otters. One juvenile otter was feeding on a large crayfish, while the other was feeding on a small salmonid (approximately 5" long).

In year 3, the survey was conducted on September 30, 2001 from 1145 – 1300 under overcast conditions with the temperature approximately 60°F. Six species of birds were recorded and 1 raccoon (Table 1). An attempt was made at recording species' behavior other than general singing or flight. One observation was made through an interaction between a kingfisher and a crow where the crow, upon seeing the kingfisher, immediately flew over to flush the kingfisher off its perch; a behavior considered to be territorial. The raccoon was observed by track. General observations were made regarding the use of the park in its relation to wildlife. It was evident that the general public was heavily using the project area. Several people and their dogs were present during the entire survey, which lent itself to observing the interaction between the public and the project area. It was clear that the ducks present were acclimated to human contact, as it was observed that several of the ducks were being fed from people near the pond. Another observation was that throughout the entire project area, dogs and dog tracks were found.

In year 4, the survey was conducted over a four-day period from April 21 – 24, 2003, usually from 0545-0800. Weather conditions varied from overcast to overcast and rain. The temperature usually ranged in the low 40's. Several species of birds were observed daily, in addition to two mammals (Table 1). In all, a total of 19 species of birds were observed over the four-day period with varying displays of activity. It was determined that two pairs of red-winged blackbirds may have been nesting in two clumps of cattails given the male and female displays around these patches. Fresh beaver sign was found throughout the project area, both in fresh cuttings and beaver skid trails. Over the course of the four days, it was clear that beavers were active in the project site due to the cutting of young willow trees and one cedar tree during the survey. The cuttings were being taken upstream (Thornton Creek) via Lake Washington (based on beaver skid trails). At one point, a person walking by indicated that there was a beaver dam further upstream; this was not investigated further. The beaver had been attempting to block the out-flow of the pond by damming it with willow cuttings. As a general observation, it was noted that the project area had more species activity than the adjacent unaltered Matthews Beach Park. This was attributed to the amount of cover available for birds than the "park-like" habitat of Matthews Beach. It was also noted that as daylight progressed, several species of birds became active at different times, but seemingly consistent each day (i.e., white-crowned sparrow and red-winged blackbirds when observer arrived, followed by starlings 10-15 minutes later, then yellow-rumped warblers 45 minutes later). No tracks were observed in any of the track plots over the four days.

As in year 3, it was clear that the public and their dogs were heavily using the project area. Even at such an early hour, the same people and their dogs would arrive and walk the project site. Some dogs were on a leash while others were not. Because of this type of use, it is assumed that both the beaver and raccoons observed during this survey were probably using the site at night.

With the level of disturbance observed daily, any ground-dwelling wildlife would probably use the site nocturnally or not at all.

Table 5-1. Species occurrence based on annual survey.

Species Occurrence	*Year 1*	*Year 2*	*Year 3*	*Year 4*			
				Day 1	*Day 2*	*Day 3*	*Day 4*
Birds							
Killdeer	X						
Belted kingfisher	X	X	X			X	
Violet green swallow	X						
Barn swallow	X						
American robin	X	X		X	X	X	X
Wilson's warbler	X						
Oregon junco	X	X					
European starling	X	X		X	X	X	X
Northern oriole	X						
Red-winged blackbird	X	X		X	X	X	X
Bushtit	X						
House finch	X						
Black-capped chickadee	X	X	X	X	X	X	X
Mallard	X	X	X	X	X	X	
Rufous hummingbird		X					
Tree swallow		X		X			
Song sparrow		X					
American crow		X	X	X	X	X	X
Black-headed grosbeak		X					
House finch		X					
House sparrow		X					
Glaucous-winged gull	X	X					
Ring-billed gull	X	X					

Table 5-1 cont.

Species Occurrence	Year 1	Year 2		Year 3	Year 4			
					Day 1	*Day 2*	*Day 3*	*Day 4*
Yellow-rumped warbler					X	X	X	
Gadwall					X			
Downy woodpecker					X			
Loon						X	X	
Great blue heron								X
Chipping sparrow								X
Mammals								
River otter								
Beaver					X	X	X	X
Raccoon				X	X	X	X	X

5.4 Conclusions

In reviewing the previous four years of survey results, and taking into consideration the written condition of the project area prior to restoration, it is safe to say that the efforts of restoration have had some positive result by way of wildlife habitat, albeit relatively minor. Because of the plantings, the pond construction, and the footpaths, one can conclude better wildlife cover, somewhat less disturbance, and increased forage opportunities for both mammals and birds.

The methods in which the wildlife surveys were conducted were marginal at best at trying to document the success of this project. With no baseline data to compare to, the increases expected in the Wildlife Benefit Analysis cannot be fully realized. To fully understand the wildlife uses of this area, a more comprehensive study plan should be developed to study the interaction between urban wildlife and the recreational impacts associated with this area. Conclusions from this type of study can help define what wildlife objectives are attainable given the current constraints on this habitat.

It is somewhat obvious that in order to fully achieve the objectives set forth in the Wildlife Benefits Analysis, that there be restrictions put on dog use in the project area, as well as the use by the general public. In fact, Matthews Beach Park is not designated for off-leash dog use by the Seattle Parks Department. It is also obvious that the restoration area is part of, and adjacent to, a recreational park that will continue to receive heavy use, and that the likelihood of keeping people and their dogs out of the project area is unrealistic. However, to help alleviate some of the potential adverse interactions between the public and the project area, placing educational signs/material informing people of the wildlife objectives, and requesting that they “tread lightly”, particularly during certain times of the year, may help the project area reach some of its stated goals. It was noted that during the final survey effort, the kiosk board did not have any information on it other than a small poster depicting ecosystem functions. Also, the only cue depicting this area as a dog-leash area was a sign located on the bridge going over Thornton Creek from the Matthews Beach side. No sign was posted in the project area.

Because of the current, one-time cursory nature of this type of survey in addition to its relatively short monitoring period (four years), the likelihood of collecting meaningful data with the ability to draw comparisons is considerably low. In order to better achieve the project objectives, it is recommended that a more robust study plan be developed to study the interaction between urban wildlife and the recreational impacts. This type of study would not only help determine wildlife use, but would also provide an opportunity to observe human and wildlife interactions. As stated previously, the current relationship is somewhat problematic. In order to fully achieve the project objectives, as they currently exist, it is important to educate the public. This can be achieved by using the empty kiosk board to state the wildlife objectives in plain language, indicate the need for people to leash their pets, and educate them on why it is important for them to be considerate to sensitive times of the year for varying wildlife species. If simply educating the public does not suffice, then other measures may need to be employed. For example, (1) fencing the area off from the public and advertising it as a "wildlife viewing area", or (2) fencing portions of the site off during sensitive (breeding) times of the year. At any rate, something must actively be done to help minimize the apparent effects currently seen at the site.

One immediate recommendation to help promote habitat growth and species use is to protect a portion of young trees (primarily young cedars and some willows) from beavers while at the same time, allowing some willows to be cut annually. This can be accomplished by placing mesh around the trunk, as is the case with several older trees currently on site. This is relatively inexpensive and easy to do. Another recommendation is to place (partially buried) snags of varying condition in the project area to attract snag/cavity-dependent species such as woodpeckers, nuthatches, chickadees, etc. Another recommendation is to lay large logs in varying conditions of decay throughout the project area to promote native mollusk and amphibian use. This has been done in the northern area of the project, where cottonwood trunks and rootwads were placed after being removed at the request of the sponsor for safety reasons when the project was constructed (mature cottonwoods may sometimes drop branches, creating a public safety issue). Cedar trunks and rootwads were placed in the pond to serve as fish cover; they have not yet waterlogged to the point of sinking.

Given the overall objective of this site to function as a public recreation area, the expectation of managing this area concurrently for wildlife may be optimistic. The efforts taken so far to date constitute steps to include wildlife in some fashion, but the expectations may be higher than what is realistically achievable given the current management of this area. Until steps are taken to curb the level of disturbance, little increase in wildlife use is expected.

5.5 Recommendations

- This site lends itself well to an on-going study of the interactions between wildlife and the recreational impacts associated with restoration projects in an urban setting.

- Restrictions on dog use, as well as the use by the general public, could enhance the habitat values of this site. Educational signs/material informing people of the wildlife objectives of the project may help the project area reach some of its stated goals.

- Protect young trees from beaver browse.

- Place upright snags and large logs throughout the site as habitat features.

6. REFERENCES

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APPENDIX A

FISHERIES SCIENCE CONSULTANTS INC. THORNTON CREEK DATA

THORNTON CREEK SPAWNER SURVEY RESULTS (All Survey Reaches)

Fisheries Science Consultant's for the City of Seattle

(this data has not been changed in any way by the Corps of Engineers)

CHINOOK

Year	Live	Dead	Redds
1999	5	2	3
2000	0	2	6
2001	8	4	4
2002	1	2	0

SOCKEYE:

Year	Live	Dead	Redds
1999	0	0	0
2000	9	9	17
2001	6	18	14
2002	3	11	2?

COHO:

Year	Live	Dead	Redds
1999	2	6	2
2000	25	93	31
2001	32	70	34
2002	5	15	8
2003	0	0	1

CHUM:

Year	Live	Dead	Redds
1999	0	0	0
2000	0	0	0
2001	2	1	0

STEELHEAD/RAINBOW:

Year	Live	Dead	Redds
2001	0	0	8
2002	6	1	6
2003	2	0	3

CUTTHROAT:

Year	Live	Dead	Redds
2001	29	6	52
2002	266	35	319
2003	167	7	313

Notes:

1) In 1999 and 2000 spawner surveys were made only in the fall, on a weekly basis, from the first week of October through the last week of December. In 2001, surveys were also made weekly from March 23 to April 23. In 2002 and 2003 winter/spring surveys commenced the first week of January and extended through the last week of May.

2) Reach descriptions:

Mainstem Thornton Creek: Mainstem surveys began at its entry to Lake Washington at Matthews Beach Park and extended upstream through the Meadowbrook Pond complex to its forks just off 35th Ave. N. E.

South Branch Thornton Creek: South Branch surveys began at its junction with the North Branch. Until midway through the spring of 2002, the South Branch survey reach typically ended at the Lake City Way culvert outlet. After late March of 2002 the surveys were extended upstream of Lake City Way based on reports from residents that cutthroat trout were able to pass the Lake City Way culvert. Also, in the fall of 2002 passage past the Lake City Way culvert was improved by the City. Beyond Lake City Way, surveys were extended to the mouth of Victory Creek.

Willow Creek: Willow was typically surveyed from the first culvert above its junction with the South Branch to a barrier culvert about 400 feet upstream.

North Branch Thornton Creek: North Branch surveys began at its junction with the South Branch. Until midway through the spring surveys of 2002, surveys ended at 35th Ave. N.E. because no fish were thought to ascend beyond the last of a series of board and cement weirs between Little Brook and 35th. However, reports from residents indicating that cutthroat and a few salmon were ascending beyond 35th and over a 4-5 foot high waterfall just upstream, prompted extension of the survey reach upstream to 25th Ave. N.E.